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A CONTRIBUTION TO THE LIFE HISTORY OF THE ALLEGHENY CAVE
RAT, *NEOTOMA MAGISTER* Baird.

BY SAMUEL N. RHOADS.

In 1857, Prof. S. F. Baird described a fossil *Neotoma* from the bone caves of Pennsylvania in a final paragraph under caption of *Neotoma occidentalis*, on page 498 of his work on the Mammals of North America. It reads: "The bone caves of Pennsylvania have furnished me with several lower jaws of a fossil *Neotoma* considerably larger than the largest specimen even of any recent species which I have seen. The body could not have been less than twelve inches in length; it differs from the others in the wider and more massive molars, the lobes of which are all more nearly equal than in the rest, and all rounded, not angular. The inner and outer sides of the molars are very nearly symmetrical, and the indentations or folds of nearly equal depth. The axis of the condyloid process is quite oblique, and the condyle below the level of the coronoid. The species may be called *N. magister*."

In 1893 Mr. Witmer Stone received two specimens of a cave rat in the flesh from South Mountain, Cumberland County, Pennsylvania, taken at an elevation of 2,000 feet, at a point known as Lewis's Rocks, about six miles from the village of Pine Grove in the same county. These he described¹ under the name *Neotoma pennsylvanica*, making no comparisons in the description between his new species and *N. magister*, the type specimens of which came from a valley cave about 20 miles distant from Lewis's Cave. Since then a large series of "fossil" specimens of *N. magister*, included among the complete collections from Hartman's and Durham Caves, and on which Prof. Joseph Leidy based his paper on "Fossils in Caves and Crevices of the Limestone Rocks of Pennsylvania,"² have been found stowed away in the Museum of the Academy of Natural Sciences. Among them is a mandible of *N. magister*, labeled from "Harrisburg Cave," presented by the Smithsonian Institution, and no doubt from the type lot on which Baird based his original notice of *magister*. Besides

¹ Proc. Acad. Nat. Sci., Phila., 1893, p. 16.

² Rep. Penna. Geol. Surv., 1887, pp. 1-20.

these the Academy possesses another collection from Hartman's Cave, made last year by Mr. H. C. Mercer during his re-exploration of that cave,³ and containing among others the only extant cranium of *magister* in which the nasal bones are intact. There are also two alcoholic specimens of a cave rat from Wythe Co., Virginia, collected in 1868 by Prof. E. D. Cope. These, together with Mr. Stone's types of *N. pennsylvanica*, two stuffed skins of the same from the Pennsylvania Alleghenies, and an alcoholic specimen shown me from Mammoth Cave, Kentucky, by Mr. G. S. Miller, form the basis of my examinations respecting the relationships, distribution, and probable identity of *magister* and *pennsylvanica*. Prof. Leidy has enumerated the entire collections from these caves, among which he records "92 mandibular rami, 13 pairs of upper maxillæ, numerous limb-bones," etc., of "*Neotoma floridana*," which, he states, appear to accord with similar remains referred by Prof. Baird to a *supposed extinct*⁴ species with the name of *Neotoma magister*." Most of these still exist in the Academy. The Durham Cave material is more scanty, but includes a more complete cranium (No. 3,542) than any from the Stroudsburg Cave. This cranium lacks nasals, pterygoids, right squamosal, malar, and occipital bones, and is from a rat hardly one year old.

The subjoined table of measurements, in millimeters, of the best of this material, together with those of *N. floridana*, kindly furnished me by Messrs. H. H. & C. S. Brimley, may be considered ample enough for a critical comparison between the forms in question:—

³ Proc. Acad. Nat. Sci., Phila., 1894, p. 96.

⁴ Italics mine.

COMPARATIVE BODY AND SKULL MEASUREMENTS OF *Neotoma magister*, *N. pennsylvanica*, AND *N. floridana*.

Catalogue No.	Sex.	Tail.	H. foot.	Ear (from crown).	Occipito-nasal length.	Zygomatic width.	Nasal length.	Interorbital constant.	Mandib. length.	Mandib. width.	Alyeolar length (lower molars).
3542	Yg. Ad.	<i>N. magister</i> , Durham Cave, Bucks Co., Pa. (Cranium meas. approximate; sup. cit.)			50.5	28.5	20.2	6.8	34	16.5	10
3543	Ad.	<i>N. magister</i> , Hartman's Cave, Monroe Co., Pa. (Perfect right mandible.)							35.2	16.5	9.7
3544	Ad.	<i>N. magister</i> , Hartman's Cave, Monroe Co., Pa. (Perfect left mandible.)							33.9	16.3	9.6
3545	Ad.	<i>N. magister</i> , Hartman's Cave, Monroe Co., Pa. (Perfect right mandible.)									
3546	Ad.	<i>N. magister</i> , Harrisburg Cave (Cumberland Co.), (L. Mand.; cond. and ang. broken.)	184	41.5	24	54	21.5	7	30.9	15.3	9.9
3547	Ad. ♂	<i>N. magister</i> , Cave Austinville, Wythe Co., Va. (In alcohol)	400	167	40	22	51.2	25	20	7	30.5
3548	Ad. ♀	<i>N. magister</i> , (Cave Austinville, Wythe Co., Va.) (In alcohol, not fully ad.)	375	158	41	22					14.6
1001	Ad. ♂	<i>N. magister</i> , Allegheny Mts., Pa. (Stuffed skin tail docked; no skull)	392	185	41	20	54	27	21	6.6	30.5
156	Ad. ♀	<i>N. pennsylvanica</i> , Lewis's Cave, Cumberland Co., Pa. (Type)	403	185	41	19	53	27	20	7	31
157	Ad. ♀	<i>N. pennsylvanica</i> , Lewis's Cave, Cumberland Co., Pa. (Dup. type.)	416	190	42						15.3
2753	Ad.	<i>N. floridana</i> , Southern States. (Skull.)				48.2	24.5	16.2	6	27.6	14
1127	?	<i>N. floridana</i> , Gainesville, Florida. (Skull; Amer. Mus. N. H. Coll., file Stone.)				49.8	25.2	18.5	6.1	28.5	13.8
1129	?	<i>N. floridana</i> , Gainesville, Florida. (Skull; Amer. Mus. N. H. Coll., file Stone.)				50	25	18.9	7.3	27.5	12.2
1542	Ad. ♂	<i>N. floridana</i> , Hancock Co., Miss. (Very old specimen.)	400	183	38	50	25.2	20	6.2	28.7	13.8
1077	Ad. ♂	<i>N. floridana</i> , Hancock Co., Miss. (Fide Brimley Bros.)	389	175	38	26					
1540	Ad. ♀	<i>N. floridana</i> , Hancock Co., Miss. (Fide Brimley Bros.)	411	196	38						
1412	Ad. ♀	<i>N. floridana</i> , Hancock Co., Miss. (Fide Brimley Bros.)	374	180	38	27					
1082	Ad. ♀	<i>N. floridana</i> , Hancock Co., Miss. (Fide Brimley Bros.)	404	195	41 (?)	26					

Prof. Baird's description of *magister* aims to distinguish it from all forms of the genus known to him by its large size and massive, rounded molars. So far as I have examined the species of *Neotoma* now known, and which number five times as many as were recognized in Baird's day, I find *magister* to be somewhat larger than any other. It has a comparatively short tail, but the length and girth of body considerably exceeds that of other species whose total length may average more than in a series of *magister*. It is a satisfaction to thus confirm the appropriateness of Baird's specific name. As to its cranial characters, *magister* presents us with the largest skulls I have examined in this genus, but the comparative size and shape of the molars as given by Baird cannot be said to be diagnostic. It is probable when Prof. Baird made these comparisons he only possessed specimens of old individuals, in which this peculiarity of the molars is always apparent, and does not vary to any great extent among specimens of *N. fuscipes*, *floridana*, or *cinerea* of same age, and is of the same general character in all. The same may be said of the folding and indentations of the enamel in very old specimens. Younger specimens of *magister*, both fossilized and recent, show a very close resemblance in their molar dentition to *floridana* and *cinerea* of same age. The incisors and rostral portion of the skull in *magister*, however, are much wider and heavier than in any other *Neotoma* I have seen. Compared with *N. floridana* (to which *magister* both physically and geographically shows the closest alliance) it may be noted from the table of measurements that the recent and fossil crania of the cave rat are much larger than in the wood rat. In superficial proportions the difference is less apparent, but in the following particulars their divergence is constant and specific :—

1. The post-palatal notch of *magister* is acuminate, often sharply so, at other times bearing in its apex a minute, blunt point, directed posteriorly; in *floridana* the post-palatal margin is broadly and evenly rounded or nearly square cut between the opposing last molars, the pterygoids being more divergent and relatively shorter.
2. In *magister* the slits separating the palatal from the sphenoid bones are often nearly ankylosed; in *floridana* they are more widely separated.
3. The interorbital depression and supraorbital ridges of the frontals in younger specimens of *magister* are very decided; in *floridana* nearly obsolete.
4. As above stated, the greater relative breadth of incisors, maxillaries, and nasals in *magister*.

Externally, *magister* is most conspicuously known from *floridana* by its densely hairy and sharply bicolored tail. This member is relatively shorter than in *floridana*, and the lateral divergence of the longer hairs gives it a depressed appearance, which is almost exactly reproduced in half-grown examples of the bushy tailed ash-colored rat of the northern Rocky Mountains. The correlation of development in this character and in the shorter ears, between animals of such widely separated but similar environments, both of which trace their ancestry to progenitors inhabiting a semi-tropical climate, is a significant fact. In body colors, *magister* is readily distinguished from *floridana* by its plumbeous grayness and lack of brown above, by the fulvous areas of opposing sides of lower hind neck reaching nearly across the throat, and by the blackish areas around the eyes and at base of whiskers.

It therefore appears that we have in *N. magister* a large cave rat, quite distinct from the wood rat of the Gulf States, and which, so far as existing remains are known to us at this date, is the same animal as *N. pennsylvanica* Stone.

As it now stands, however, the case is a peculiar one. The evidence in favor of making *pennsylvanica* a synonym is conclusive so far as it is based on known facts, but the impossibility of ascertaining the perishable external characters of those individuals whose fossilized remains formed the types of Prof. Baird's description, establishes a possibility that they represent an animal we would now consider separable from the living form. Were the specific peculiarities of the different members of the genus *Neotoma* based on cranial characters of constant value, the identity of *magister* and *pennsylvanica* would be clearly established by my examinations, but as yet they have not been so distinguished by anatomists. That it is probable good cranial characters can be formulated for the species of this genus deserving recognition, I feel confident. On this basis, as recently applied by Dr. Merriam,⁵ it is apparent to me that *pennsylvanica* will not stand as a specific name, nor can it, from the very nature of the case, be a candidate for sub-specific honors.

The points confirmatory of the identity of fossilized and living specimens of *N. magister*, already demonstrated by cranial characters, may be stated:—

⁵ Proc. Biol. Soc., Wash., 1894, pp. 117-128.

1. *Recent date of fossil remains taken in contact or direct association with Neotoma magister in Pennsylvania caves.*—While no data have been preserved as to the relative position in Hartman's Cave of the extinct *Dicotyles pennsylvanicus* and *Castoroides ohioensis* with respect to more recent remains, it is interesting to note that the following mammals, yet existing in America, were found in association and in precisely the same stages of recent or ancient preservation in the shallow upper layer of the cave floor:—

<i>Lynx canadensis.</i>	<i>Arvicola pinetorum.</i>
<i>Lynx rufus.</i>	<i>Sitomys americanus.</i>
<i>Urocyon cinereo-argenteus.</i>	<i>Neotoma magister.</i>
<i>Vulpes pennsylvanicus.</i>	<i>Arctomys monax.</i>
<i>Canis lupus nubilus.</i>	<i>Sciurus niger cinereus.</i>
<i>Mephitis mephitica.</i>	<i>Sciurus carolinensis pennsylvanicus</i>
<i>Putorius ermineus.</i>	<i>Sciurus hudsonicus.</i>
<i>Procyon lotor.</i>	<i>Tamias striatus.</i>
<i>Ursus americanus.</i>	<i>Lepus sylvaticus.</i>
<i>Scalops aquaticus.</i>	<i>Lepus americanus.</i>
<i>Blarina talpoides.</i>	<i>Bison bison.</i>
<i>Adelonycteris fuscus.</i>	<i>Alces americanus.</i>
<i>Vespertilio gryphus.</i>	<i>Rangifer caribou.</i>
<i>Castor fiber canadensis.</i>	<i>Cariacus virginianus.</i>
<i>Fiber zibethicus.</i>	<i>Cervus canadensis.</i>
<i>Erethizon dorsatus.</i>	<i>Equus caballus.</i>
<i>Mus decumanus.</i>	<i>Homo sapiens.</i>
<i>Arvicola pennsylvanica.</i>	

2. *The Sonoran derivation of the Genus Neotoma indicates its comparatively recent post-glacial advent into North Temperate latitudes.*—Dr. Coues has attempted to trace, by the scant evidence then known to him, the probable derivation from *magister* of the four existing species of *Neotoma* recognized in the Monograph of North American Rodentia.⁶ The evidence now had, exactly reverses his hypothesis.

3. *The presence of living N. magister in the caves where fossilized remains of same occur in various stages of preservation and antiquity.*—*Magister* does not now exist in the Carlisle valley cave. It may have existed there in the early colonial days of Pennsylvania, or its life there may date back to a time when the crests of South Mountain,

⁶ Mon. N. Amer. Rod., 1877, 29, 30.

now infested by it, were yet in the loosening grip of the ice age. Mr. Paret writes me that he has no knowledge of the recent existence of a cave rat in Hartman's Cave. I have been told that such an animal is found among the cliffs and rocky crests of the Kittatinny range, on the opposite side of the Delaware River, in Warren Co., New Jersey.

4. *The lack of any trace of gnawing upon the bones of mammals, from Hartman's Cave, not now existing in America, as contrasted with the uniformly rat-eaten condition of the bones of those known to have inhabited Pennsylvania in the history of man.*—The specimens of *Dicotyles pennsylvanicus* and *Castoroides ohioensis* from Hartman's Cave are ungnawed, as is likewise the ramus of caribou there taken, while those of the beaver, elk, and bison, animals recently exterminated in Pennsylvania, show the unmistakable marks of a rat's teeth.

It, therefore, appears that the evidence, so far as we know it, tends only to establish the identity of the fossil *Neotoma* of Baird with the species now living in the same localities. On the other side the argument is purely presumptive, and if we admit a distinction (no differences being proven) between *magister* and *pennsylvanica*, the fossilized remains of foxes, wolves, beavers and other animals found in association with the rat bones in the Carlisle and Stroudsburg caves are as fully entitled to specific separation from their living Pennsylvania representatives as are the rats. No one, who would be unwilling to thus follow such a precedent to its logical conclusion, can consistently endorse the precedent. Had Prof. Baird been aware of the facts as we now know them, the question would never have arisen, or if it had, would have been decided in the case of the rat as it was decided in that of the fox and wolf and beaver.

Habits and distribution of Neotoma magister.—I paid a visit to Lewis's Rocks, the type locality of Mr. Stone's specimens of *pennsylvanica*, in the spring of 1893, for the purpose of obtaining some knowledge of the animal's habits. The rocks lie at the top of the mountain and form the culminating point of a rocky outcrop, topping the ridge for a mile or more in this locality, and which at intervals assumes a very rugged and castellated outline. The cave rats live in the more inaccessible fissures and clefts of these rocks, selecting for their dormitories those which are most secure from the approach or entrance of the predaceous animals which abound in such situa-

tions. The entrances and passageways to these abodes are loosely barricaded with sticks, stones, leaves, feathers, bones, horse and cow droppings, buttons, glass, tin, egg-shells, cartridge-cases, and other cast-away evidences of the sojourn of men and animals in this spot. Many of the sticks are three to four feet long and an inch in diameter, and must have required the concerted strength of several rats to move, and not a little ingenuity to convey up and over the precipitous clefts to their resting-place. The bones were those of deer, smaller carnivora, birds, and other animals brought thither by man and beast, or which had sought refuge among the clefts to die. I was unable, from the nature of their fastnesses, and lack of time and proper implements, to penetrate their dormitories, and owing to the pilfering foxes, lost the only specimens that got into my traps. One half-grown rat was seen running among the rocks. It was lighter gray than adult specimens. Quantities of gnawed acorn hulls strewed their hiding places, and were the chief evidences of the diet of this species. These acorns grow abundantly on the scrub oaks, *Quercus banisteri*, characteristic of these mountain tops. While its main food supply is vegetable, no doubt these rats are omnivorous, and take every opportunity to satisfy their carnivorous appetite. The gnawed condition of the bones of recent mammalia found in Pennsylvania cave deposits, is, to my mind, almost solely due to the work of this quadruped, a critical examination of these marks showing not only their rodent origin, but that their size and character fit no tooth so well as that of *magister*.

I am informed by Mr. H. C. Mercer (whose recent explorations of Virginia caves has been ably outlined in a Bulletin of the University of Pennsylvania, dated July 4, 1894) that the Virginia cave rats build a sub-globular nest of grass, etc., on the cave floor, and that these are so well made internally as to resist considerable kicking about. Prof. E. D. Cope, who secured the two specimens of *magister* tabulated above, from a cave in Wythe Co., Virginia, tells me that these nests are placed at or near the sides of the cave, and are often large enough to fill a bushel basket.

The habitat of living *Neotoma magister* cannot be verified by a representative series of specimens from connected localities, but from those now in possession, and the testimony of several of my correspondents in Pennsylvania and New Jersey, it is co-ordinate with the

Alleghenian Fauna, as restricted by Dr. J. A. Allen,⁷ and extends northward toward the Canadian Fauna as far as Potter County, Pennsylvania, in the west, and probably along the Blue Ridge to the Delaware River. It is possible that it may be found in northern New Jersey.

The specimens of *Neotoma* taken on the Hudson River, by John G. Bell, and mentioned by Baird in his work on mammals, are, apparently, from the table of measurements, large *N. floridana*.

It is doubtful if *N. magister* ever inhabited the State of New York, and the specimens taken by Mr. Bell were probably imported in a cargo of southern lumber.

Probably the earliest reference to the Allegheny cave rat in literature is made by the Swedish naturalist, Peter Kalm, in 1759, in his book of Travels, where he quotes John Bartram, of Philadelphia, as authority for the existence of such an animal in the "Blue Mountains." This reference is quoted by Pennant in his History of Quadrupeds, page 441, under caption of "American Rat," as follows: "Mr. Bartram (in Kalm's Trav., ii, 48) mentions the rat, but does not determine the species, which lives among the stones and caverns in the Blue Mountains, far from mankind: comes out at night, and makes a terrible noise, but in very severe weather keeps silent within its holes." William Turton in his *Systema Naturae* (1802, p. 80) enumerates an American rat to which he gives the name *Mus americanus*. His description is mainly a quotation of Pennant's account, above cited, of the same animal. Were not Turton's binomial antedated by the *Mus agrarius* var. *americanus* of Kerr (*Syst. Nat.*, 1792, 231), now accepted as the first tenable name for the eastern white-footed mouse, *Sitomys americanus* (Kerr), it would have a strong claim, in the light of our present knowledge, to precedence over Baird's specific name, *magister*.

⁷ Bull. Amer. Mus. N. Hist., 1892, pl. viii.